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AN ESSAY

ON

The Origin and Development

OF

THE SOLAR SYSTEM.

BY

ERNEST R. G. GROTH, M.D.

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INTRODUCTORY REMARKS.

It is only after very considerable hesitation that I have at last ventured to place before the public certain views, which, in my judgment, enable us to explain and elucidate on the basis of physical laws—long, firmly established—those peculiarities and complexities of the mechanism of the boundless universe, which have hitherto remained enveloped in so much profound mystery.

In the following pages I propose to indicate the probable cause of axial rotation, the obliquity of planetary axes towards their orbits, especially that of Uranus, the order and formation of the planets with their attendant satellites, the specific gravity, the formation of the immense number of Planetoids, the glacial periods of our earth, and in brief outline, to place before the reader some account of the laws which, I conceive, have regulated the compression and condensation of the once vapourous masses as they, in process of time, assumed to themselves, the form and structure, we observe in our own earth, and of her companions in space.

I am emboldened thus to trespass upon ground hitherto held sacred to the keenest astronomers and profoundest analysts, from the consideration,that it sometimes happens—through, may be, a fortunate concurrence of suggestive circumstances—that a tyro in science,may suspect the existence of, and be enabled at last, to formulate laws, which had altogether escaped the practised observations of master minds. Of this character were, I suspect, the earlier discoveries of Watt, Davey, and others.

Not being a native of this country, and having but a moderate command of the English language, especially so far as regards its accepted scientific Terminology, I feel I must claim the reader's indulgence, wherever it may appear —as I fear will at times be the case—so imperfect, or involved as to interfere somewhat with clearness of expression or illustration. For the rest, I cordially invite the closest criticism of the principles I enunciate, so that, should I have advanced an unsound theory, it may be speedily exploded, and I, as a lover of truth, be enabled to rejoice over the pricking of yet another scientific bubble.

In this pamphlet I have purposely omitted mathematical demonstration of any kind, analytical or otherwise, which would have been superfluous to scientific readers, and wholly unintelligible to those who are (the great majority) unskilled in the higher mathematics.

It must not be surmised that this little work is one of those miserable attempts to " find out God," with which the world is now-a-day so often troubled. It is rather a very humble attempt to place a fitting interpretation upon those of His laws, of which He, in the exercise of His eternal wisdom permits us to see the working and the motive. We may, indeed, trace the growth of worlds from imponderable cosmic dust, we may note the almost infinite path of a wandering comet, and even conjecture the amount and nature of the force, which urges it on its interminable path, but still beyond all this, remains unseen, unknowable, and unapproachable in His infinite Majesty, the great Father, the great Creator, the Almighty God. It is then, with the utmost reverence and in a prayerful spirit that I approach my present task, fully conscious of the difficulties, yet trustful, that by His help our efforts may lead to a better understanding and appreciation of those marvels and mysteries with which he sees fit to environ our being.

ERNEST R. G. GROTH.

5, WEYMOUTH STREET,
PORTLAND PLACE, LONDON, W.
September 26th, 1884.

THE hypothesis that solar systems have been evolved from vast but almost impalpable clouds of cosmical matter, which moving in space, have gradually condensed, assumed more or less spherical form,[*] acquired axial rotation, settled into curvilinear paths, and ultimately cast off satellites, seems fair and sound and one which has therefore justly received the sanction and approval of many master minds. But whilst it is admitted that Newton's great law properly accounts for orbital motion, other circumstances have been suggested as necessary in order to fully account for and explain the rotation of those nascent heavenly bodies about their axes.

One distinguished philosopher is of opinion that such cosmical clouds originally received motive impulse from lateral contact or collision with other similar bodies, existing in space; and following up this idea astonomers have even proceeded to calculate and assign the nature and approximate intensity of the force, which must have been exerted in order to produce axial rotation of heavenly bodies.

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[*] Masses of a fluid character have a natural tendency to assume a spherical form. For instance, this is the case with a drop of water suspended from a twig or leaf, and with molten metal let fall from a height. This property is also forcibly illustrated in the manufacture of leaden shot. Where, however, rotation about a fixed axis takes place, a spheroidal form is produced. As a perfect sphere would not remain in equilibrium, for in consequence of revolution all the parts have a tendency to recede from the axis and will not keep their relative places, except they be retained by the pressure and attractions of the other parts, and if the largest section perpendicular to the axis of revolution be called equator, the parts about the *Equator* being furthest from the axis, and moving quicker than the rest, will tend to recede from the axis more than the others, and will so recede, unless they be restrained by some opposing force which acts upon them more than upon the other parts, and in the spherical form there will be no force thus acting unequally on different parts. Therefore there cannot be equilibrium.

But in adverting to this speculation it naturally occurs to us to inquire whether contact of this kind between such loosely formed bodies, *could* produce more than a mere local disturbance of molecules, which would rearrange themselves in a wave-like manner, after impact, but produce no effect whatever in the way of positive axial rotation. Or again, on the other hand, may we not be reasonably led to suppose, that the meeting of such gaseous bodies would result in nothing less than the merging of one into the other, and that they would henceforth exist only as a single sphere?

Before touching further upon this subject we may just call attention to the fact, that a comet has been observed to dash towards the sun with enormous velocity; but when apparently on the point of being absorbed in that luminary, to deflect its course in another direction and become lost in space; now, supposing this kind of phenomenon to be due to the repulsion of bodies in a similarly electric condition, and that *all bodies in space* are so charged;* would it not be absolutely impossible for the species of contact in question to have taken place?

Before advancing another view of axial rotation and calling attention to certain extraordinary and suggestive analogies, which manifestly subsist in the Universe, or at least are apparent in our system, I would fain say one word on the subject of orbital motion.

If a planet were acted upon by no force it would proceed uniformly in a straight line. Hence a body moving in its curvilinear path, must be perpetually deflected *from* the tangent by some force tending towards that side, on which the orbit is concave. The planets move round the sun nearly in circles, and describe about the sun areas which are nearly proportional to the times—therefore, the forces by which they are acted upon tend nearly to the sun. This is the text-book statement, but I would ask, if a body be acted upon by "no force," why should it move at all? Is some initial force, perhaps rectilinear in direction, here presupposed? And may not this force be the outcome of some kind of electro-magnetic energy, more or less inherent in cosmical particles?*

---

* Gilbert.

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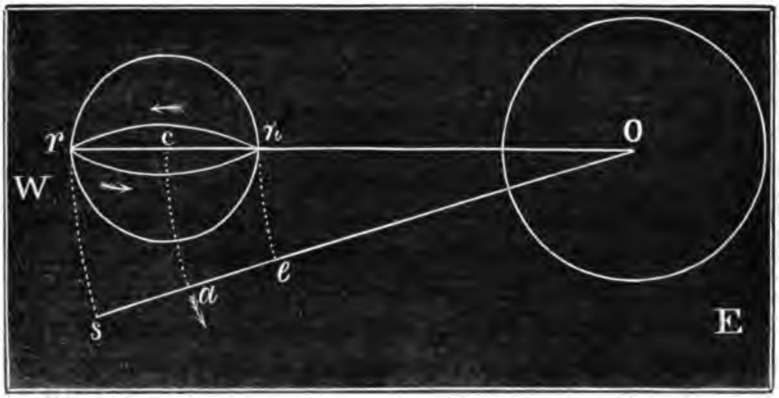
* Gravitation and electric action. The learned Mossotti saw reason to believe that all molecular forces which tend to hold together or unite material bodies, depend upon the electric fluid, and that gravitation may not be an elementary principle but some manifestation of electric action. Summing up Mossotti's conclusions, a brilliant writer observes: "When the material molecules are inappreciably near to one another, they mutually repel each other with a force which diminishes rapidly as the infinitely small distances between the material molecules augments, and at last vanishes. When molecules are still further apart, the force becomes attractive. At that particular point where the change takes place, the forces of repulsion and attraction balance each other, so that the molecules of a body are neither disposed to approach nor to recede, but remain in equilibrio. If we try to press them nearer, the repulsive force resists the attempt, and if we endeavour to break the body so as to tear the particles asunder, the attractive force predominates and keeps them together. This is what constitutes the cohesive force, or force of aggregation, by which molecules of all substances are united. The limits of the distance at which the negative action becomes positive, vary according to the temperature and nature of the molecules, and determine, whether the body which they form be solid liquid, or aëriform. Beyond this material point the attractive force increases as the distance between the molecules augments till it attains a maximum, when the particles are more apart, it diminishes, and as soon as they are separated by finite or sensible distances, it varies directly as their mass and inversely at the squares of the distance, which is precisely the law of universal gravitation.

THE COSMICAL CLOUD, ITS ORBITAL PATH AND AXIAL ROTATION.

Let us conceive a vast nebulous mass indefinitely great in extent, which by the influence of some great attractive power has been constrained to travel in a given path. Let the central force be, for example, the mighty gravity of a cluster of stars, like the Pleiades, and the path, a conic section, called an ellipse. The inconceivably great vaporous cloud rolls on in space, assuming in obedience to the immutable law of equilibrium, the necessary spheroidal form and increasing in cohesion and density, until at last it becomes a gradually solidifying ball—and infant world! But with this progression in a vastly extended orbit, there has now come to be compounded another and especially important movement, namely, that of axial rotation, under the influence of which every point on the globular surface, reckoning in a direction from pole to pole, was made to move with varying velocity, the maximum being, of course, where the circumference was greatest, in the equatorial region.

The composition of this may be better understood by the reader, if he will refer to the accompanying diagram and explanation.

Let O be the centre of the central mass, whose influence determines the curved path of the nebulous globe, c the centre of the globe itself, $r\,n$ its diameter in the direction c O, and $c\,a$ the direction of the orbital movement around O. Then r being further from O than n, it will describe in *the same time* a larger orbit around the central body. Then the velocity of a given mass towards r being greater than that of a similar mass near n, the point r would naturally be constrained to rotate over in the direction of n, or in other words the globe of which *c* is the centre would begin to turn round on its own axis, and that in the direction *c a* of the orbital path, which in this case was from West to East. We have to imagine a vast vapourous mass, possessed of axial rotation and revolving around some central seat of power, such as we have said the Pleiades may possibly be each hour of its majestic progress, working changes and modifications in its stupendous form. Gradually the filmy cloud of etherial vapours has become compressed, inconceivably intense heat generated, and at last a semi-fluid fiery globe takes the place of what was once a vague chaotic



mist of cosmic matter. Increasing velocity, and the tendency of its component particles to approach their common centre of gravity have produced the necessary bulging outwards of the equatorial region, and thus, after the lapse of, perhaps, countless ages, there has been created an orb, whose vast activities and boundless potentiality will fit it to become the centre and parent of a stately family of worlds, even such as that which constitutes our planetary system.

THE PLANETARY SYSTEM.

Very great rotatorial velocity in a semi-fluid mass of spheroidal form may easily be understood to generate in that mass a tendency to project portions of its incandescent substances from the protuberant equatorial regions. Let us suppose then, that in this way masses have been thrown off eight successive times or (if, as some believe, there exist an intermercurial body) nine successive times, and we shall have pictured before the mind's eye the process by which our Solar system was primarily called into existence. The body first so hurled into space was, undoubtedly, that which is now the most distant, namely, Neptune; the others, Uranus, Saturn, Jupiter, Mars, the Earth, Venus, Mercury,* and, if it exist, the intermercurial body Vulcan, coming next in order, the self-luminous and intensely-heated central ball, from which all these originated, being the magnificent orb we call the Sun, as yet much less developed than we see him now, and, perhaps, not presenting exactly the same phenomena, but still the lordly giver of light and motion to his stately progeny. We will not pause here to explain all the reasons, which have induced astronomers to conclude the existence of a planet revolving in an orbit between Mercury and the Sun. It will suffice

---

* The mean distance of the planets from the sun and their revolutions are nearly as follows :—

	Miles.	Periods in days and fractions.
8. Neptune	2,850,000,000	60,180·86
7. Uranus	1,822,000,000	30,688·30
6. Saturn	906,000,000	10,759·219817
5. Jupiter	494,000,000	4,432·584821
4. Mars	144,760,806	686·979646
3. Earth	93,000,000	365·256374
2. Venus	68,891,486	224·700787
1. Mercury	36,841,468	87·969258

to say, that many persons maintain they have seen it in transit, on the Sun's disc.*

In addition to the bodies above enumerated, there are between Mars and Jupiter a great number of small planets, called the Asteroids, how many it is impossible to say, but up to the present time about 242 have been discovered. These exhibit the peculiarity that their orbits are greatly inclined to the ecliptic, in one instance (Pallas) as much as 34°, whereas the orbits of the larger bodies, constituting the Solar System, have *their* orbits nearly coincident with this plane. Their eccentricities being at the same time very considerable, it has been conjectured on excellent grounds—as we shall presently show—that these bodies originally formed one planet, which has been broken up by some great convulsion, the fragments being thereby thrown into orbits deviating much from that, in which the entire planet may have revolved. The mention of the Asteroids brings us at once to the consideration of a most important point in our task, namely, that of establishing proofs of the former existence of a planet, which moved in an orbit intermediate between that of Mars and Jupiter. For convenience, when speaking of this body, we shall henceforth style it Planet X. It will be observed, on the supposition, that this additional body did once exist and that Vulcan, either in the form of a single planet or in separate masses, revolves around the Sun inside the orbit of Mercury, there must have been ten, and not as mentioned above, nine successive projections; it is moreover manifest that each individual planet must from time to time, have had its orbit greatly extended, and these extensions would naturally have taken place with each new creation, that is every time a fresh body was thrown off from the parent orb.*

---

* If this phenomenon be due to other causes than the transit of the planet, and we admit that the intermercurial body has never been observed at all, we may still conceive its existence possible, independently of its visibility. For being the youngest body of the system it may perhaps be heated so far as to be in a high degree self-luminous (in which condition it would naturally long continue from the very fact of its close proximity to the sun), in this case it might of course easily pass unseen over the bright surface of the sun, and when situated laterally be completely eclipsed by the Sun's effulgence.

There can be little difficulty in understanding, that if a body is retained in position at a given distance by the attraction of a certain mass, if that mass be reduced, its power over the attracted body will be proportionately lessened, and it will accordingly recede to a greater distance. This much being premised, we can perceive how in accordance with the same law our Earth must have been thrice subject to sudden recessions from its primary, these changes in her orbit, having occurred at the creation of Venus, Mercury, &c., Planet X in its turn, we may suppose being removed further from the Sun at the time Mars came into existence. Now, as on each of these occasions the Sun's volume must have been lessened and its circumference consequently contracted, we have as an *immediate* consequence a proportional loss of surface velocity, that is, supposing no subsequent acceleration ensued, of which there is *no evidence.* This being the case each succeeding projection became less forcible than its predecessor, and thus we have the order of the various orbits most fully accounted for.

Thus, according to our view, the Sun, which we have seen in course of development from its primitive chaotic condition, has been the cause of the existence and motions of the planets, and promises to govern their destinies till the end of conceivable time. It would, of course, be foreign to our purpose and far beyond the scope of this little work, even to glance at the various disturbances and their compensations, which take place in the movements of the heavenly bodies, but taken on the whole, their order may be considered as invariable, the major axis of their orbits and their mean motion remaining always the same.* But it is important to remark that, generally speaking, the older plants are of less density† than those of recent creation, whereas they are at the same time of far greater size, presumably, because at first when the Sun was less compact, fluid in fact, in structure, large masses were more readily detached by contrifugal action than was the case later on, when a certain increase of cohesion had ensued. But it will be seen that this emperical law is not rigidly true of all the planets. Neptune and Uranus are, for instance, of smaller size than the two next succeeding bodies, Saturn and Jupiter, Neptune being also of greater density than Saturn, and nearly equal in that respect to Jupiter. This circumstance is, perhaps, to be explained by some peculiar affection of the Sun's surface at the point of projection, which may have been undergoing local changes of a transient character at that time, favourable to the detachment of smaller portions, having a more developed structure than those gaseous masses, which formed the beginning of the other planets. This appears the more feasible when we consider the startling changes, which, at the present time appear to be still in progress on and around the Solar disc, and these changes were in all probability yet more sudden, stupendous and unaccountable in former stages of the Sun's existence than they are even at the present moment.

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* It is shown by writers on Dynamics, that in a system of particles revolving about a fixed centre, the momentum, that is, the sum of the *products of the mass of each into its angular velocity* and the distance from the common centre, is a constant quantity, that is, unless the system be deranged by some extraneous cause.. This law insures the invariability of the earth's axial rotation, and so regulates the length of day and night.

---

* The mean orbital velocity of the planets is as follows :—That of the Earth being taken as unity, Neptune 0·18246, Uranus 0·22833, Saturn 0·32378, Jupiter 0·43481, Asteroids (in mean) 0·58677, Mars 0·81013, Earth 1·00000, Venus, 1·01758, Mercury 1·06073.

† Density of the planets, the Earth as before taken as unity, Neptune ·230, Uranus ·178, Saturn ·140, Jupiter ·242, Mars ·948, Earth 1·000, Venus ·903, Mercury 1·220.

We must also remember that bodies at the distance of Neptune and Uranus would cool, and therefore contract their dimensions more rapidly than those in closer vicinity to the central source of heat.

Having now spoken of axial rotation, the motion of translation in space* and the relative density and size, it remains to say a few words on the inclination of the axes of these bodies to the planes of their several orbits and creation of their satellites, after which, we shall pass on to consider planet X and the formation of the Asteroids, concluding with a few pages devoted to an examination of the peculiarities of Saturn with his marvellous system of moons and rings, at which point we shall be able to indicate some very remarkable analogies, which go far to strengthen the general views we have advanced as to the creation and arrangement of the Solar System.

Of the greatest importance to the future career of the projected planetary bodies was the degree of inclination adopted by their axes of rotation in respect to the planes of their orbits, for upon this circumstance, it is well known, depends the distribution of heat and cold over their surface, or in other words the existence of their various seasons. As we have already pointed out the sun's body at the time of throwing off its attendant worlds was probably not only in a state of considerable fluidity, but subject, as indeed it is at present, to many changes of its surface, as regards density in those parts of the equatorial zones from which the bodies in question were originally projected, and perhaps also never-ceasing chemical and electro-magnetic changes of which we can form no adequate conception. If then when these commotions were proceeding, a large mass of the sun's substance had been hurled into space, it is easy to conceive that the mass could scarcely be homogenous, that some portion of its bulk must in fact be heavier than others. The effect of this condition upon the projected body would be to cause it to deviate somewhat from the original plane of projection in the direction to which its heavier side was pointed at the moment it became detached from the parent body. Here we have a reason for the inclination of a planet's orbit to the plane of the sun's equator* and the same cause,—preponderance of mass,—may be considered also as regulating the inclination of a planet's axis of rotation to its own orbit; and this, as we have before remarked, is a principle cause of the changes in the seasons. These changes are due to the sun's influence at different times upon a given region, and this again depends upon his height above the horizon, and the time he remains there. The changes in the length of the day, in the height of the sun, and in the seasons, are produced by the joint operation of three causes:—Inclination of the axis of rotation to the orbit, the annual motion round the sun in that orbit, and the axis remaining always parallel to itself. Thus we have in the Earth,—whose axis of rotation makes an angle of 66° 32′ with the plane of its orbit, or, which is the same thing, leans 23° 28′ towards it,—well defined and greatly different changes in the seasons, whilst Jupiter, whose axis is almost perpendicular to the plane of its orbit, can, for this reason, exhibit very little variety of climate. His summer and winter will be very much alike indeed.

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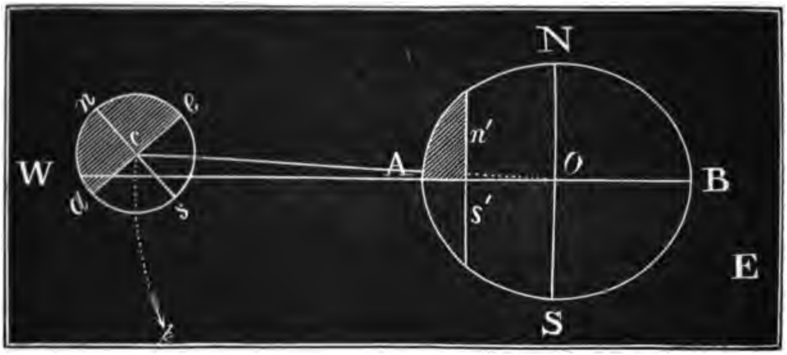
* This is the elliptical motion of the orbits previously described. Kepler has shown that the square of the time, which any planet takes to complete a revolution round the sun, is to the square of the time which any other planet takes to complete its orbit, as the cube of the first planet's distance from the sun, is to the cube of the second planet's distance from that body.

---

* Inclination of the orbits to the sun's equator:—Neptune 9° 2′, Uranus 6° 33′ 20″, Saturn 5° 22′ 18″, Jupiter 6° 50′ 2″, Mars 5° 50′, Earth 7° 19′ 23″, Venus 3° 57′ 15″, Mercury 4° 10′ 39″.

The accompanying figure will further elucidate the meaning of the foregoing statement.



Let *O* be the centre of an oblate spheroid, rotating about the axis N S, A B its equator, *n′ s′* a portion of its equatorial zone, the shaded part *n′* being supposed denser than the unshaded section at *s′*. Then, when the fluid, or nearly fluid mass *n s* has assumed the necessary spheroidal form, and reached the distance A *c*, it will not be found to have its centre *c* in the plane of the equator A B, but in a plane *c* A inclined to the plane A B produced; *c k* now becomes the orbit of the body *n a s e*. Again, during projection the axis *n s* of the globe *n a s e* assumes a position oblique to its orbit, the obliquity varying with the excess of one hemisphere's density over that of the other.

In the case of our Earth we may conclude the northern hemisphere, being that, which contains more land than the southern, was directed away from the sun at the time it was projected from that body, and therefore its polar axis became inclined in the manner described.

The inclination of the planets to their several orbits appears to be as follows :—

Neptune	...	56° 53′	37° 7′
Uranus	...	46′	89° 14′
Saturn	...	63° 11′	26° 49′
Jupiter	...	86° 54′	3° 6′
Mars	...	61° 18′	28° 42′
Earth	...	66° 32′	23° 28′
Venus	...	72° —	18° —
Mercury	...	70° —	20° —

We now come to planet X, whose destruction we maintain was the true cause of the formation of the Asteroids. The abstraction of mass caused by the creation of Mars, necessarily lessened, to some extent, the attractive power of the sun, whose hold upon the remoter planets became, consequently, relaxed, and their orbits proportionately extended ; in fact, as Mars was called into existence, planet X and those moving outside his orbit flew further away. Thus, suddenly removed from the source whence they derived their heat, far into the intensely cold regions of outer space*, it would be small wonder if their surfaces endured an immense and instantaneous diminution of temperature. It will, however, be easily perceived that when planet X receded, and became expunged from the solar family, it was, by reason of its smallness, and the period of its projection from the sun, pre-eminently liable to that fate to which it ultimately succumbed. At the time of its birth the sun's surface had attained a certain degree of coherence, and was undoubtedly not so intensely hot as when it gave off the masses which formed the more mighty orbs, now circling in remoter orbits.

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* Lambert, Fourier, and other philosophers, who have investigated the subject, place the temperature of space 58° below zero (Farenheit) but it has been since ascertained to be considerably higher.

These bodies when sent forth to commence their giant career were of an enormously high temperature, and, necessarily, surrounded by a zone or atmosphere of glowing vapour: this fact combined with their vast bulk would prevent the sudden cooling, which, by reason of its comparative smallness, the consistency of its mass, and position in space, further recession from the central body produced in planet X, a sudden cooling, which, as we have shown, signalised its complete effacement as a member of the Solar system. Now Mars joined the Solar family when X was yet in a state of intensely glowing heat, so that its sudden recession and cooling, consequent upon that planet's birth, converted it, as it were, into a vast Rupert's Drop.* † Hence the catastrophe, which brought about its destruction, and at the same time signalised the appearance of the Asteroids. Removed further from the sphere of the Sun's attraction, X next approaches nearer to that of the great outlying planets, and this seals his fate. What a scratch does for the Rupert's drop, the pull occasioned by Jupiter's attraction, effects for the doomed planet, the thin crust is rent, and forth in a thousand different directions fly his meteoric fragments, some being doubtless surrounded with portions of the now fast cooling interior mass. Ceres, Pallas, Juno, and uncountable numbers of smaller bodies are cast into many and different orbits, some may be, after circling around and around other worlds, to fall upon, as meteorites and increase—if but imperceptably—their mass, or in the case of the very smallest ones to become vaporised by the heat generated in passing through the comparatively dense medium of a mundane atmosphere into which they thus probably become incorporated; during this process exhibiting to us the phenomena with which we are so well acquainted in the case of shooting stars. Many little orbs then, some not larger than an English county, go travelling on in well defined but much eccentric orbits.* It has been objected that at its disruption, Planet X could not very well have projected portions of its bulk to the great distance from its assumed orbit, at which we now find some of these tiny planets moving, but experiments have been made with hollow spheres of iron, which leave no doubt, that the sudden contraction of the shell of such bodies, or the expansion of imprisoned gases within them could break up the mass and project its fragments far and wide.

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* Rupert's drops, so called on account of their supposed inventor Prince Rupert. They are made by dropping melted glass into cold water, which condenses the outer surface and imprisons the heated particles, while in a state of repulsion. These drops have a long and slender tail and will bear a smart stroke with the hammer without breaking, but when scratched, or the tail broken, they will explode with a loud report.

† It may not be out of place here to observe, that many considerations point to the fact that our earth, and presumably, other planetary spheres are not, so to speak, solid, those which have cooled and contracted most, as for instance, our own orb being of great density towards the surface only. That the planets have a cavernous structure, and that we, here on this earth, walk upon a crust or shell, whose thickness bears but a very inconsiderable proportion to the diameter of the globe, we inhabit. If this interior space were even filled with atmospheric air, that air at a distance of 30 or 40 miles from the surface would become as dense as water, and that water 300 miles lower down would become in consistency almost like quicksilver, and what the compression might be at a depth of 4,000 miles seems almost beyond computation. It is, however, but reasonable to suppose that this extreme condensation may be counterbalanced by increased elasticity, to advanced temperature of the mass, centrifugal action, and possibly other causes, of which at present we are ignorant.

It is a remarkable circumstance that of the number† already discovered in the zone they occupy midway betwixt the orbits of Mars and Jupiter, there are found a much less proportion (about one-fourth) in the vicinity of the latter planet, the majority lying rather towards Mars. There is, however, a small group, (namely, Sibylla, Freia, Maximiliana, Camella, Hermione, Hilda, Silvia, &c.) which lies comparatively close to Jupiter, and for this circumstance we shall presently attempt to suggest a reason.

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* Taking the mean distance of the known Asteroids, which may be assumed as the radius of our destroyed planet's orbit, we have a very strong confirmation of the so-called Bode's or Titius' law.

† The total number of these bodies is estimated to be not less than 20,000,000, with a collective mass, not greater than one quarter of the Earth, so that they occasion no perceptible perturbations in the movement of Mars around the Sun. If, as has been suggested the influence

In view of explanations which we propose to give later on, and in order to facilitate those explanations, we must pause here to bid the reader to bear in mind, that there exists a certain peculiarity, of a very striking character, in the order of Saturn's satellites, namely, that they follow a certain law, to which, however, there is in one instance a singular exception—taking Saturn's diameter as unity, we have the following arrangement, in which it appears there is a seemingly inexplicable hiatus—that is, between the Vth. and VIth. of the accompanying Table; there is, in fact, a moon missing between Rhea and Titan.

Names and Number of Satellites.	Distance from Saturn in terms of its Semi-diameter.	Distance in miles.	Revolution.			
			D.	H.	M.	S.
VIII. Japetus	64·36	2,298,900	79	7	53	40
VII. Hyperion ...	26·78	998,610	21	7	7	41
VI. Titan	22·14	826,946	15	22	41	25
?	?	*470,856	13	22	40	30
V. Rhea	9·58	356,125	4	12	25	11
IV. Dione	6·84	254,978	2	17	41	9
III. Tethys	5·34	198,996	1	21	18	26
II. Enceladus ...	4·31	160,770	1	8	53	7
I. Mimas	3·36	128,120	0	22	37	23

N.B.—Transferred from German into English miles.

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of Jupiter prevented the rolling up of these portions of the Gaseous rings into one separate mass, we might expect to find he had attracted many more to his immediate neighbourhood.

* These are roughly approximate figures for this Satellite.

THE GLACIAL PERIODS OF OUR PLANET.

It is admitted by geologists that the temperature of our globe, especially in the northern latitudes, was once much higher than at present, for we find there, embedded in the tertiary and diluvial strata, remains of enormous tropical plants, and of gigantic animals. The bones and tusks of the mammoth are so numerous in Siberia, that one must conclude the animals once inhabited these regions in enormous numbers, and it is of course certain that they required a great and constant supply of plants, herbs, &c., for their support, such as a frozen country could hardly be expected to produce. We may therefore conclude that a sudden lowering of the temperature in this, as well as in every other part of the globe arose, and destroyed animal as well as vegetable life. Had only a gradual decrease of heat taken place, then these animals would doubtless—following natural instinct—have found their way to warmer parts, where abundance of food might have been procured. Thus they would not have remained to perish in these latitudes. That some sudden catastrophe of this kind really happened is further proved by numerous facts, all of which it would be impossible to condense into the limits of this little pamphlet. In the year 1772 an entire mammoth was found embedded in a block of ice on the northern coast of Siberia. In 1770, Pallas discovered, on the banks of the river Wilui, an entire rhinoceros, with the remains of pine-leaves in his mouth. This animal was entombed in an upright position, which fact plainly shows that the animal must have perished in consequence of a sudden accession of cold. This, at least, is a reasonable supposition, which it certainly is not, to believe that beasts of prey, herbivorous animals, and human beings, could peacefully live together in caves, or even associate, except under the influence of fear, which, it is well known, will for a time deprive the most savage animals of their ferocity. And what more calculated to excite terror in the breasts of both man and beast, than this almost instantaneous transition from summer warmth, to the dread cold of an arctic winter! It is possible that this strange brotherhood, which we see indicated in these great heterogenous collections of organic remains, was brought about, not perhaps by panic alone, but from the necessity which existed, that these creatures should find refuge from withering cold. No theories hitherto advanced have satisfactorily explained so sudden and terrible a change of temperature as that now under consideration. Nothing appears to offer so feasible an explanation of the glacial periods as the recession of our planet from the sun when Mercury came into existence.

THE SATELLITE OF VENUS AND THE PHOSPHORESCENCE OF THE DARK SIDE OF THE PLANET.

It has been asserted that a satellite to this planet was first observed by Fontana on November the 15th, 1645, and for the last time, in 1764, by Rödkier, March 3rd and 4th, and by Horrebov, also of Copenhagen, in company with three other observers on the 10th and 11th of the same month in that year, and again on the 28th and 29th of March of the same year, by Monbarron in Auxerre. The circumstance that it has not been observed since that period, even at the times of the various transits of Venus, is no absolute proof that it does not exist, and that those who assert they have seen it, have merely been the victims of an optical illusion. It merely shows that it is only visible in certain favourable positions. It cannot be seen, for instance, when nearly the whole of its enlightened hemi-

sphere is turned to the earth, this on account of its great distance at such times and also of its nearness to the Sun; nor could it be expected to be seen when the planet is near its inferior conjunction, as it would then present to the Earth only a very slender crescent, besides being in the immediate neighbourhood of the Sun. If the plane of the Satellite's orbit be nearly coincident with the plane of the planet's orbit, it will be frequently hid by the interposition of that body, likewise when passing along its surface in the opposite point of its orbit, and if one side of this body should be unfit for reflecting much light, that will also partly account for its being seldom seen. Perhaps the most likely position, when it might be observed, would be when near the time of the planet's greatest elongation. At these times very frequently a phenomenon is perceived, which is usually designated "Phosphorescence," and which appears lately to have scarcely received proper attention from astronomical observers; but admitting the distance of the supposed existence
Satellite, it would not seem rash to attribute this phenomenon to light reflected from that body. Something like this appearance is indeed seen in our own moon, when in its crescent form after new-moon. This explanation of the so-called Phosphorescence is, at least in our opinion, the most probable, which has as yet been offered.

A GENERAL VIEW OF THE LUNAR SYSTEMS.

As we have already pointed out, it is highly improbable that the larger planets could have become sufficiently cold and hardened at their several recessions to render them subject to anything approaching such a catastrophe as that which befel planet X. Their satellites must have been due to portions of their mass being left behind during flight in space, perhaps also in some instances to tangential projection of their loosely cohering parts from that portion, where the velocity was at a maximum and circumference greatest; that is, from the equatorial regions. In the case of the great planets, whose volume is so immense and which have remained of little density, we have the larger number of satellites. The Earth with an equatorial diameter of 7,925 miles and a diurnal motion of 23h. 56′ 4″ has but one moon; Mars, whose diameter is about 4,100 miles, and a period of rotation of 24h. 37′ 20″, is endowed with two very small moons.

Planet X, whose place was next in the rank of distance, would naturally have also possessed its moon, and that unquestionably a small one, since—as we have elsewhere pointed out—the planet itself was small. Jupiter, with a diameter of 87,000 miles, rotating about his axis in less than ten hours, we find possessed of four moons, and that, which succeeds it, Saturn, the grandest object visible in the heavens, if we except the Sun itself, with a diameter of more than 75,000 miles, has eight satellites and a stupendous system of rings. What these rings are and the object they probably subserve, we shall discuss later on. It is well, however, to note in passing, that his volume is nearly 800 times that of the earth, although his density is less than water. He rotates about his axis in 10h. 29′ 17″. Uranus, a stately planet, with a diameter of say 33,304 miles, has four moons; its period has not yet been discovered, but its density is put at ·178; that of the earth being considered unity. Neptune, who comes last, with a diameter of 34,684 miles, has but one moon, and its time of rotation, as in the case of Uranus, is still unknown, but the density assigned to it is ·230.

The orbits of the four moons of Jupiter coincide nearly with his equator, the angles of inclination being, taken in order from the innermost ·002° ·018° ·084° ·409°. The orbits of the satellites of Saturn coincide nearly with his equator, or which is nearly the same thing, with the rings, with the exception of the eighth, whose inclination is about 21° 61′ towards the equator. The reason we gave for the inclination of a planet's orbit will also hold good for that of Japetus, whose distance from the parent body is extremely remarkable. Titan, the sixth satellite of Saturn, is of surprising dimensions, its diameter being about equal to that of the planet Mars. It seems highly probable that this body came into existence about the time of the mighty Jupiter's creation, which is the sixth planet, if we admit our planet X, represented by the Asteroids, or the seventh, assuming the existence of Vulcan. This circumstance appears to bear important evidence in favour of our theory. It is not surprising that Saturn at the formation of Jupiter, whose mass amounts to ·3 of that of all the other planets conjointly, assumed a very rapid axial rotation and was thus specially prepared for projection of masses from its body. How considerably, what is called centrifugal force, has tended to produce Saturn's compression, is very plain, from the fact that its polar diameter is $\frac{1}{10}$ less than the equatorial diameter. Saturn has undergone eight, and if we admit for the gap in his system, another Satellite—which for the sake of convenience, we may call small x,—nine successive projections. But these repeated withdrawals exhausted the fluid matter, and its mass became tenacious, and could not permit any more projections. Now, as condensation and axial rotation increased, masses were of course detached from the equatorial region, which probably floated around the equator in the form of rings. Such detachments seem to have occurred at three distinct intervals. The rapid axial rotation drove, specially the heavier substances, towards the equator, from whence they were at last detached. Therefore, only lighter substances were left on Saturn, and this accounts for his low specific gravity. Besides the eight moons, Saturn [illegible] rings which [illegible] nearly coincide [illegible] of Saturn. The circumstance that the rings lie nearly in the plane of Saturn's equator while the orbits of the moons are inclined to that plane points distinctly to the fact that these moons have been projected while the rings were [illegible] (see page 31).

THE RINGS OF SATURN

We have seen that Saturn at last could not project any more of its mass except in the form of rings. Saturn's body having contracted and left the rings independent, it would be seen that these rings, or as we will for convenience style them, the one ring* in the course of its rotation round about the parent spheroid endeavoured—as it was bound to do—to form itself into a spheroid. Now, this it was manifestly under existing conditions quite unable to accomplish, but the mere tendency to assume this figure must have caused a rounding of the edges of the annular disc and consequently a splitting up of its body, and as this was of comparatively light consistency, each portion of it speedily commenced in obedience to the dynamical law, to form itself into a separate sphere or globe; but it is evident from what has gone before that the whole host of these bodies would themselves rotate round about Saturn nearly in the plane of his equator. That Saturn's rings are thus composed of a cloud of satellites has often been surmised, we merely venture to suggest how that cloud came into existence. That these rings are altogether more luminous than Saturn himself is explained by the very circumstance under which they came into existence; cast away from the planet, and the planet's heat in a laminated form, so that their component particles became exposed to the lower temperature existing outside the range of the planet's atmosphere, they, the rings—and as a matter of course, the bodies—to which they gave birth, were harder, less transparent; in fact, more able to reflect light than was Saturn himself.

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* As a matter of fact these rings are slightly inclined to each other and are not quite concentric with the body of the planet.

The formation of planets by the sun, and the satellites by their respective primaries, seems thoroughly evidenced by their ratio of distance. All these bodies would have had their masses cooled and contracted quickly in proportion as their bulk was less than the sun's, and their distance from him became greater.

In regard to this ratio of distance before mentioned, we note Mercury is about 82 solar semi-diameters from the sun's surface; the innermost moon of Uranus about 6·44 semi-diameters from the surface of that planet; the nearest moon of Jupiter is 5·05 semi-diameters from its surface; and in the case of Saturn we find the distance of his inner ring to be 2·36 of his own semi-diameter.

It is noticeable that when a planet has more than one moon, the remoter ones are of greater specific gravity than those more adjacent to the primary. Reasons for this will be found in that portion of this little treatise, where we have discussed the general formation of planets and other heavenly bodies.

That planets and satellites could not have been formed from gaseous rings, floating around the central body is hard to believe. If such rings existed at all, it would have been but for a very short space of time, in fact only until that inevitable disruption occurred, which caused their substance to be determined in the way we have described into a vast number of globular bodies. Hardening of material, and velocity of rotation, are the causes in question, and we shall endeavour to show in our concluding pages that the Sun himself is no exception to the remarkable law we have endeavoured to formulate.

ANALOGY

between the systems of the

SUN and SATURN.

low specific gravity

1st., namely, SUN, 0·242.	SATURN, 0.178.
PLANETS.	SATELLITES.
10. Neptune great distance from the Sun.	9. Japetus, great distance from Saturn. Also similar in that respect to Neptune.
9. Uranus.	8. Hyperion.
8. Saturn.	
7. Jupiter, greatest planet.	7. Titan, greatest satellite.
6. Gap (Asteroid).	6. Gap.
5. Mars.	5. Rhea.
4. Earth.	4. Dione.
3. Venus.	3. Tethys.
2. Mercury.	2. Enceladus.
1. Vulcan.	1. Mimas.

Japetus, with a diameter of about 3,000 miles, and Hyperion, whose diameter is estimated to be about 800 miles, were in all probability created at one and the same time, namely, as Saturn was projected, for Neptune and Uranus were at that time much nearer to the Sun than now, and exercised on Saturn's loosely connected mass so much attracting influence during his approach towards them, that masses detached themselves from the equatorial region and receded under the influence of the above-named planets partly in a tangentical direction, but their attractive influence ceased in a great degree with their own recession and Saturn remained the victor. Japetus is much greater than

Hyperion, for Neptune's mass* is greater than that of Uranus, so consequently is also his attractive power. Neptune and Japetus show us clearly the way we have to take in forming an opinion about the formation of our Solar system, Jupiter and the gaps lead us further on, and Mimas tells us that the system is completed. On the projection of Jupiter, Saturn receded further, and left behind on his path some further portions of his mass which was greater on account of the greater attracting influence of Jupiter, and thus we see created Titan with a diameter of about 4,000 miles, the greatest of Saturn's satellites. The first formed satellites had also to recede from their respective parent bodies, as the mass of the latter became lessened, and with it their attractive power; and the size of the satellites shows us *under which planet's influence they were formed.* On the formation of planet X, with his attendant, Jupiter, Saturn and their older companions receded, and Saturn left behind him small *x*—its lost one. Now, Mars having entered the ranks, X with his satellite receded from the sun and small *x*, in consequence of Rhea's formation, from Saturn. This sealed their common fate.† They were all three in a similar condition, and met the same fate. But in this fearful and simultaneous catastrophe left evidence for them all. The gaps for X and small *x*, and the group of the before-mentioned asteroids for X's attendant, at the time of the occurrence of the explosion must have been between X and Jupiter. Rhea's diameter is about 3,000 miles, and Mars exercised, in spite of his smallness, but on account of his nearness, a greater attracting influence than afterwards, the earth did for Dione, and Venus for Tethys, whose diameters are nearly equal and about [illegible] miles. The diameters of Enceladus and Mimas are about [illegible] miles, and here we find Mercury and Vulcan the active cause in their creation. We must pause here in our analogy to point out that the same peculiarity of arrangement exists when we compare the satellites of the other planets. Neptune's satellite was formed with the creation of Uranus, after which, on account of Neptune's further recession and great distance, the attracting influence of the other planets ceased, as far as satellite formation was concerned.

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* Masses of the planets compared with that of the Earth : Neptune, 18½ ; Uranus, 14½ ; Saturn, 92, and Jupiter, 310, more than the Earth ; Mars, $\frac{1}{10}$; Venus, $\frac{17}{19}$; and Mercury's, $\frac{1}{17}$ of that of the earth. The Sun's mass being much over 300,000 times that of the earth.

† See destruction of Planet X.

Uranus 4th and 3rd satellites are brighter than the 2nd and 1st, and this leads us to the conclusion that the masses and volumes of the former must be greater than those of the latter, for the attracting influence of Saturn and Jupiter was greater than afterwards was that of V. and Mars, and this seems also to be the case with Jupiter's 3rd satellite, whose greater size most likely depends, not only upon the greater interval between the projections, but also upon the greater attractive power of our earth.

The satellites of Mars are smaller, and nearly equal in size, and also, in this case, the earth and Venus were actively at work. Our earth has but one moon, and its size depended, not only upon the condition our planet was in at the time of projection, but also upon the attracting influence of Venus. According to the foregoing, it is almost impossible to escape the conclusion that Venus really possesses a moon, and that its size depends upon the influence of Mercury.

We must now return to our task, and seek for further analogy between Saturn and the sun. We saw in former pages that, with the successive formation of Saturn's satellites, the crust of the parent body had, to a certain extent, lost its fluid character, was no longer in condition to project masses, but that the accumulated matter about the equatorial regions *tended* to detach itself in an annular form. It is, we contend, to this condition that our sun has now advanced. And this circumstance suggests to us an explanation of the mysterious corona. The analogy between it and Saturn's rings should be patent to all.

The corona is a portion of the sun's mass already detached from the equatorial region, and in process of forming itself into a ring like that of Saturn, but ages will doubtless be required for its complete formation. Its outer part seems to consist of a gaseous layer, whilst that lying nearer to the sun has a more substantial nature. It is a visible fact that the corona fines away towards the sun's poles, increasing symmetrically in thickness as it approaches the equatorial regions. It is in truth the meniscus to this spheroid. As soon as the solar body contracts further, the distance of the corona from the solar body will increase and the development will take place as described for Saturn's rings.*

Our analogy, which is now completed, has, we believe, plainly shown that planets and satellites have been created by projections and recessions, and stand with each other in most intimate connection, and that leads us to the last irrefutable conclusion that another small planet exists beyond Mercury, which not only accounts for the origin of Saturn's youngest satellite, "Mimas"; but also confirms, that besides the glacial period of our earth caused by the creation of Mercury, also a second, has taken place at the recession of our planet on the formation of Vulcan, the "intermercurial planet." This fact also stands in complete harmony with geological conditions, for mighty layers of deluvia exist not only below but also between erratic blocks in the great valley of the Drance, near Martinach, and also layers of coal have been found between erratic formation, etc.

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* The process is further advanced in the case of Saturn, because being smaller it has necessarily approached maturity sooner than did its mighty parent.

CONCLUSION.

In considering any theory of the universe, it is, of course, impossible to go further back than to those *effects*, from which, considered as penultimate causes, we must commence our reasoning. We have, then, matter and force as the only elements with which we are permitted to deal and from whose various relations to each other we have to trace the progressive growth of motion and form, from consolidation of indefinitely rarified vapour into spheroidal shapes, impelled to travel at various speeds, in various paths, to the evolution of life, and the formation of the mineral and vegetable kingdoms.

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